

73. (A) (B) (C) (D) (E)
74. (A) (B) (C) (D) (E)
75. (A) (B) (C) (D) (E)
76. (A) (B) (C) (D) (E)
77. (A) (B) (C) (D) (E)
78. (A) (B) (C) (D) (E)
79. (A) (B) (C) (D) (E)
80. (A) (B) (C) (D) (E)
81. (A) (B) (C) (D) (E)
82. (A) (B) (C) (D) (E)
83. (A) (B) (C) (D) (E)
84. (A) (B) (C) (D) (E)
85. (A) (B) (C) (D) (E)
86. (A) (B) (C) (D) (E)
87. (A) (B) (C) (D) (E)
88. (A) (B) (C) (D) (E)
89. (A) (B) (C) (D) (E)
90. (A) (B) (C) (D) (E)
91. (A) (B) (C) (D) (E)
92. (A) (B) (C) (D) (E)
93. (A) (B) (C) (D) (E)
94. (A) (B) (C) (D) (E)
95. (A) (B) (C) (D) (E)
96. (A) (B) (C) (D) (E)
97. (A) (B) (C) (D) (E)
98. (A) (B) (C) (D) (E)

99. (A) (B) (C) (D) (E)
100. (A) (B) (C) (D) (E)
101. (A) (B) (C) (D) (E)
102. (A) (B) (C) (D) (E)
103. (A) (B) (C) (D) (E)
104. (A) (B) (C) (D) (E)
105. (A) (B) (C) (D) (E)
106. (A) (B) (C) (D) (E)
107. (A) (B) (C) (D) (E)
108. (A) (B) (C) (D) (E)
109. (A) (B) (C) (D) (E)
110. (A) (B) (C) (D) (E)
111. (A) (B) (C) (D) (E)
112. (A) (B) (C) (D) (E)
113. (A) (B) (C) (D) (E)
114. (A) (B) (C) (D) (E)
115. (A) (B) (C) (D) (E)
116. (A) (B) (C) (D) (E)
117. (A) (B) (C) (D) (E)
118. (A) (B) (C) (D) (E)
119. (A) (B) (C) (D) (E)
120. (A) (B) (C) (D) (E)
121. (A) (B) (C) (D) (E)
122. (A) (B) (C) (D) (E)
123. (A) (B) (C) (D) (E)
124. (A) (B) (C) (D) (E)

125. (A) (B) (C) (D) (E)
126. (A) (B) (C) (D) (E)
127. (A) (B) (C) (D) (E)
128. (A) (B) (C) (D) (E)
129. (A) (B) (C) (D) (E)
130. (A) (B) (C) (D) (E)
131. (A) (B) (C) (D) (E)
132. (A) (B) (C) (D) (E)
133. (A) (B) (C) (D) (E)
134. (A) (B) (C) (D) (E)
135. (A) (B) (C) (D) (E)
136. (A) (B) (C) (D) (E)
137. (A) (B) (C) (D) (E)
138. (A) (B) (C) (D) (E)
139. (A) (B) (C) (D) (E)
140. (A) (B) (C) (D) (E)
141. (A) (B) (C) (D) (E)
142. (A) (B) (C) (D) (E)
143. (A) (B) (C) (D) (E)
144. (A) (B) (C) (D) (E)
145. (A) (B) (C) (D) (E)
146. (A) (B) (C) (D) (E)
147. (A) (B) (C) (D) (E)
148. (A) (B) (C) (D) (E)
149. (A) (B) (C) (D) (E)
150. (A) (B) (C) (D) (E)

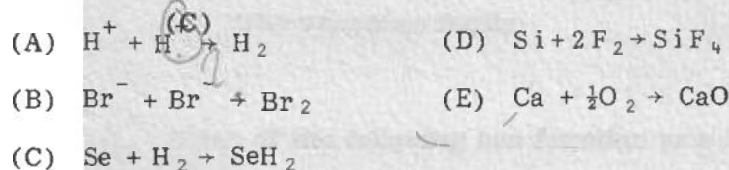
THE GRE CHEMISTRY TEST

| MODEL TEST I |

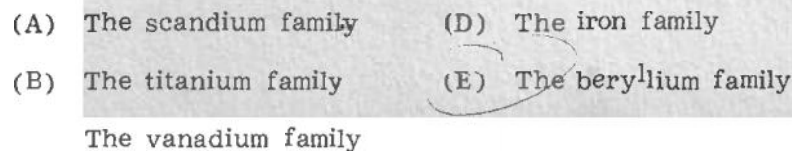
Time: 170 Minutes
150 Questions

Directions: Choose the best answer for each question and mark the letter of your selection on the corresponding answer sheet.

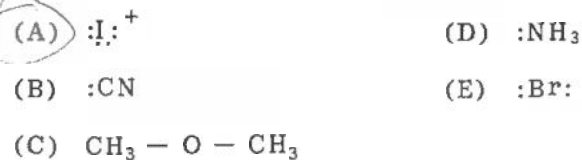
1. A covalent bond is unlikely to exist in the product of which of the following reactions?



2. Which of the following is not a member of the transition metals?



3. Which of the following can function as a Lewis acid?



4. Which of the following substances has the least ionic character in its bond?

(A) CCl_4

(D) NaCl

(B) KCl

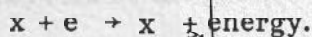
(E) BaCl_2

(C) MgCl_2

5. Which of the following best describes ionization energy?

(A) Energy needed to remove the most loosely bound electron from its ground state.

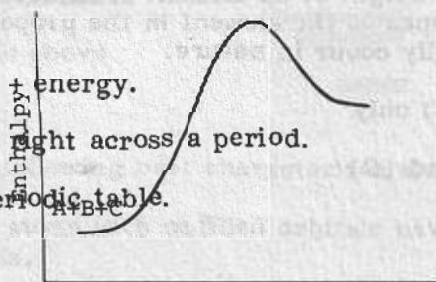
(B) It is represented by



(C) It decreases from left to right across a period.

(D) It increases down the periodic table.

(E) None of the above.



Activated
complex

$D+E+F$

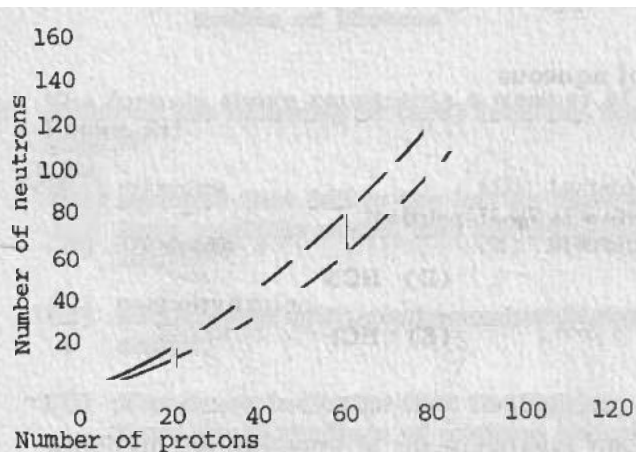
Reaction coordinate

6. The enthalpies associated with the reaction $A + B + C \rightarrow D + E + F$ is shown above. The fact that the enthalpy of $D + E + F$ is higher than that of $A + B + C$ tells us that

(A) the reaction is exothermic

(B) the reaction is endothermic

- (C) the activation energy required for the reverse reaction is higher than for the forward reaction
- (D) a catalyst for the reaction is unnecessary
- (E) the activated complex for the reverse reaction is a different species from that of the forward reaction
7. Every atom consists of electrons, protons and neutrons except
- (A) helium atom (D) boron atom
- (B) sodium atom (E) calcium atom
- (C) ordinary hydrogen atom
8. Which of the following is true for isotopes of an element?
- (A) They are atoms of the same atomic number with different masses.
- (B) The only difference in composition between isotopes of the same element is in the number of neutrons in the nucleus.
- (C) The atomic weight of an element is an average of the weights of the isotopes of the element in the proportions in which they normally occur in nature.
- (D) (A) and (C) only
- E) (A), (B) and (C)
9. Natural chlorine occurs as a mixture of isotopes. If a mixture contains 75% Cl_{17}^{35} and 25% Cl_{17}^{37} , determine its molecular weight.
- (A) 34.50
- (B) 35.50
- (C) 72.00
- (D) 70.00
- (E) None of the above



10. Which of the following is (are) true for the above nuclear stability graph?
- (A) Isotopes that fall to the left or right of the stability curve have unstable nuclei and are referred to as being radioactive.
 - (B) All isotopes with atomic number higher than 83 are radioactive.
 - (C) The curve indicates that the lighter, stabler nuclei tend to have equal numbers of protons and neutrons.
 - (D) None of the above
 - (E) All of the above
11. Which of the following best characterizes electron affinity?
- (A) Neutral atoms with unfilled orbitals having repulsion for electrons.
 - (B) Neutral atoms of noble gases having attraction for electrons.
 - (C) Neutral atoms with unfilled orbitals having attraction for electrons.
 - (D) Atoms that lie to the upper left of the periodic table.
 - (E) Atoms with low ionization potential.
12. The type of precipitate that is most difficult to filter in quantitative analysis is

- (A) curdy (D) crystalline
(B) insoluble (E) gelatinous
(C) isomorphous
13. Which of the following represents the same net reaction as the electrolysis of aqueous sulfuric acid?
- (A) Electrolysis of water (D) Electrolysis of molten NaCl
(B) Electrolysis of aqueous HCl (E) All of the above
(C) Electrolysis of aqueous NaCl
14. Which of the following is most acidic?
- (A) HClO_4 (D) HCN
(B) HF (E) HCl
(C) H_3PO_4
15. Titanium dioxide is an excellent white pigment used in the
- (A) preparation of white rubber
(B) preparation of white leather
(C) preparation of certain types of paints
(D) All of the above
(E) (A) and (B) only
16. Which of the following reactions when heated quickly produces small amounts of chlorine gas?
- (A) $\text{NaCl} + \text{HNO}_3$ (D) $\text{HCl} + \text{Br}_2$
(B) $\text{NaCl} + \text{MnO}_2$ (E) $\text{HCl} + \text{KMnO}_4$
(C) $\text{NaCl} + \text{H}_2\text{SO}_4$

17. The compound $\text{CH}_3\text{CH}=\text{CH}_2$ has a bond formed by the overlap of which of the following hybrid orbitals?

(A) $\text{SP}^2 - \text{SP}^3$ (D) $\text{SP}^3 - \text{SP}^3$
 (B) $\text{SP} - \text{SP}^2$ (E) All of the above
 (C) $\text{SP} - \text{SP}^3$

OH

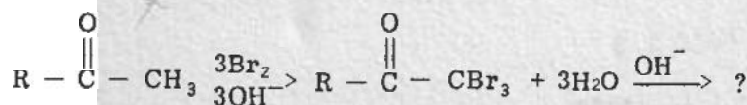
18. The formula above represents a member of the class of compounds known as:

(A) vitamins (B) S^{2-} (C) Se^{2-} (D) terpenes
 (B) alkaloids (E) steroids
 (C) carbohydrates

19. Which of the following is the strongest nucleophile?

(A) O^{2-} (D) Te^{2-}
 (E) Po^{2-}

- 20.

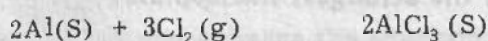


When the above reaction takes place, which of the following is the major organic product?

(A) CHBr_3 (D) $\text{R} - \overset{\text{OH}}{\underset{\text{OCH}_3}{\text{C}}} - \text{CH}_3$
 (B) HOCH_3 (E) None of the above
 (C) $\text{R} - \overset{\text{OH}}{\text{C}} - \text{CH}_3$

21. For a certain second order reaction $A + B \rightarrow C$, it was noted that when the initial concentration of A is doubled while B is held constant, the initial reaction rate doubles, and when the initial concentration of B is doubled while A is held constant, the initial reaction rate increases fourfold. What is the rate expression for this reaction?

(A) $r = k[A][B]$ (D) $r = k[A]^3[B]^1$
 (B) $r = k[A]^2[B]^3$ (E) $r = k[A]^2[B]^1$
 (C) $r = k[A]^1[B]^2$



22. For the above reaction the entropies of $Al(s)$, $Cl_2(g)$ and $AlCl_3(s)$ are 28.3 J/Kmol , 222.96 J/Kmol and 110.7 J/Kmol respectively. Calculate the standard entropy change for the reactive system.

(A) -221.4 J/Kmol (D) -504.08 J/Kmol
 (B) 725.48 J/Kmol (E) -56.6 J/Kmol
 (C) -668.88 J/Kmol

23. How would you express the absolute temperature at which a reaction occurs in terms of the free energy change of the reaction ΔG , the enthalpy change ΔH , and the entropy change ΔS ?

(A) $\frac{\Delta G - \Delta H}{\Delta S}$ (D) $\Delta H - \Delta G + \Delta S$
 (B) $\frac{\Delta H - \Delta S}{\Delta G}$ (E) None of the above
 (C) $\frac{\Delta H - \Delta G}{\Delta S}$

24. For a quantized energy system, which of the following is(are) implied by Bohr's postulate(s) of the theory of hydrogen atom:

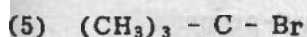
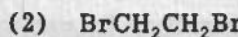
(A) A normal hydrogen atom in its ground state is a stationary proton and a revolving electron with an energy of $-21.79 \times 10^{-12} \text{ erg}$.
 (B) The energy of the electrons can take only the values given by $-21.79 \times 10^{-12} \text{ erg}/n^2$.

- (C) The hydrogen atom can emit or absorb only photons whose energy is equal to the difference between the two energy levels.
- (D) For an electron moving between any two levels, the difference in the energy of the two levels equal the energy of the radiation absorbed or emitted by the electron.
- (E) All of the above.

25. Which of the following represents the real gas law?

- (A) $nRT = (P + a/v^2)(v - b)$ (D) $nRT = (P - a/v^2)(v + nb)$
- (B) $nRT = (P - a/v^2)(v - b)$ (E) $nRT = (P + n^2a/v^2)(v - nb)$
- (C) $nRT = (P + a/v^2)(v + nb)$

26. Which of the following compounds shows splitting of peaks in its ^1H nuclear magnetic resonance spectrum?

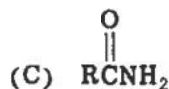
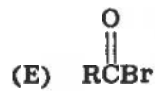
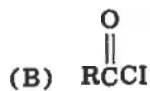
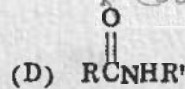


(A) (1), (2), and (3) only (D) (2) only

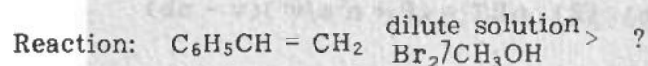
(B) (1), (3) and (4) only (E) (5) only

(C) (1) and (4) only

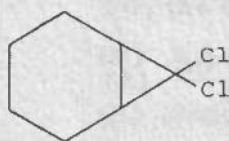
27. Acid-catalyzed esterification of carboxylic acids produces which of the following as its final product?



28. Which of the following is the major product of the reaction below?



- (A) $\text{C}_6\text{H}_5\text{CHBr}-\text{CH}_2\text{Br}$ (D) $\text{C}_6\text{H}_5\overset{\text{OCH}_3}{\text{C}}\text{Br}-\text{CH}_2\text{Br}$
 (B) $\text{C}_6\text{H}_5\overset{\text{OCH}_3}{\text{C}}\text{HCH}_2\text{Br}$ (E) None of the above
 (C) $\text{C}_6\text{H}_5\text{CH}_2-\text{CHBr}_2$



29. The hydrocarbon shown above is

- (A) 7,7 dichlorobicyclo [4·1·0] heptane
 (B) 1,1-dichlorobicyclo [2·7·0] heptane
 (C) 7,7-dichlorobicyclo [5·6·0] heptane
 (D) 3,3-dichlorobicyclo [4·1·0] heptane
 (E) None of the above

30. A secondary alcohol is formed through oxymercuration-demercuration of which of the following?

- (A) 1-hexene (D) 2,2-dimethyl-propene
 (B) hexane (E) 1-hexanal
 (C) 2-methyl-1-bromopropene

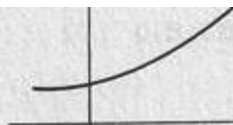
31. Which of the following is a characteristic of an isothermal change?

- (A) The enthalpy is constant.

- (B) No heat enters or leaves the system.
- (C) The system is maintained at the same temperature throughout the experiment.
- (D) The system is maintained at the same pressure throughout the experiment.
- (E) None of the above
32. The equation $\Delta G = \Delta H - T\Delta S$ tells us that a spontaneous reaction will be associated with which of the following?
- (1) Negative ΔH (2) Positive ΔH
- (3) More disordered positive ΔS (4) Negative ΔG
- (5) More ordered negative ΔS
- (A) (1) and (5) (D) (1), (3) and (4)
- (B) (2) and (5) (E) None of the above
- (C) (2) and (3)
33. In a methanol-ethanol-propanol solution (consisting of a mixture of 42.0g methanol, 35.0g ethanol and 50.0g propanol), the partial molar volumes are respectively 16.0 ml, 20.0 ml and 50.0 ml. The volume of 1.00 mole of the solution is: (take the mole fraction of CH_3OH , $\text{C}_2\text{H}_5\text{OH}$ and $\text{C}_3\text{H}_7\text{OH}$ to be 0.452, 0.260 and 0.287 respectively):
- (A) $(0.452)(16.0) + (0.26)(20.0) + (0.287)(50.0)$
- (B) $(0.26)(16.0) + (0.452)(20.0) + (0.287)(50.0)$
- (C) $(0.26)/(16.0) + (0.452)/(20.0) + (0.287)/(50.0)$
- (D) $\frac{(0.452)(16.0) + (0.26)(20.0) + (0.287)(50.0)}{(0.452)(0.26)(0.287)}$
- (E) $(0.26)/(20.0) + (0.452)/(16.0) + (0.287)/(50.0)$
34. In order for $H\psi$ to be defined, which of the following is acceptable?

(A)

ψ



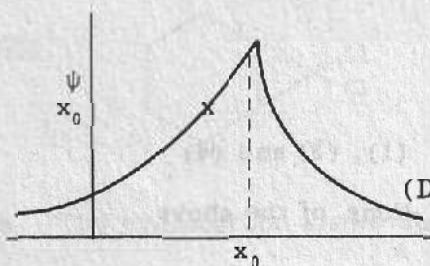
(B)

ψ



(C)

ψ



(D)

ψ



(E)

x

x

x

35. For a certain first order reaction, the time required for half of an initial amount to decompose is 3 minutes. If the initial concentration of A is 1 molar, the time required to reduce the concentration of A to 0.25M is: (take $\ln 2$ to be 0.693 and $\ln 4$ to be 1.39):

(A) 4.5 mins

(D) 8.0 mins

(B) 6.0mins

(E) 6.6mins

(C) 12.0 mins

36. What is the concentration of an HNO_3 acid solution with a pH of 3?

(A) 3

(D) -3

(B) -Antilog[3]

(E) None of the above

(C) 10^{-3}

37. Which of the following is closest to the pH of 10^{-4}M NaOH ?

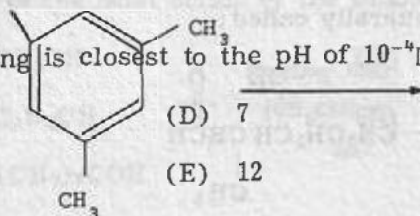
(A) 11

(B) 10.2

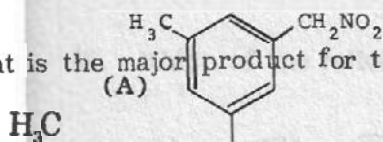
(C) 9

(D) 7

(E) 12



38. What is the major product for the reaction below?



fuming HNO_3
 $(\text{CH}_3\text{CO})_2\text{O}$
 20°C

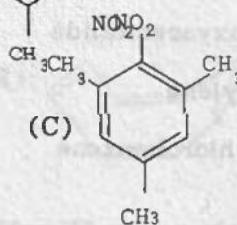
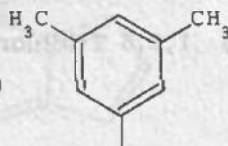
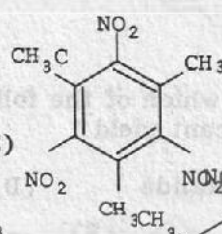
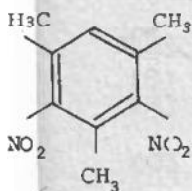
?

(E)

(B)

(C)

(D)



39. If a copper bearing material weighing 40 grams yielded 5 grams of CuO (MW 79.55), the percentage of copper (atomic weight 63.55) in the sample is:

(A) $5/40 \times 100$

(D) $40/5 \times 79.55/63.55 \times 100$

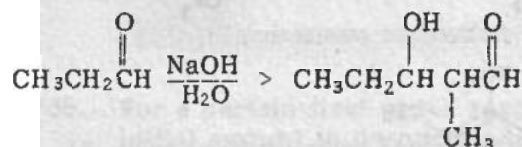
(B) $5/40 \times 79.55/63.55 \times 100$ (E) None of the above

(C) $5/40 \times 63.55 / 79.55 \times 100$

40. What is the normality, N, of a 1M solution of H_2SO_4 , given the following reaction?



- (A) 4N (D) 1N
(B) 3N (E) None of the above
(C) 2N
41. The reaction below is generally called:

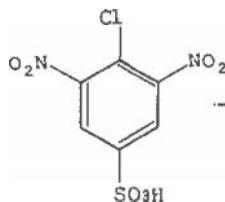


- (A) Oxymercuration-demercuration
(B) Oxidation
(C) Reduction
(D) Aldol condensation
(E) Clemmensen reduction
42. During nitration, which of the following can form more than one product in significant yield?

- (A) Methoxyacetanilide (D) P-nitro-toluene
(B) Mesitylene (E) 1,3,5 Trichlorobenzene
(C) P-dichlorobenzene



?



?

O_2N

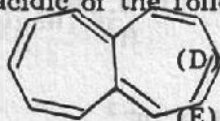
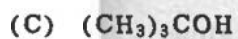
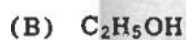
NO_2

SO_3H

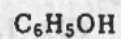
43. What are the missing reactants in the above equation?

- (A) NH_3 followed by H_2SO_4
- (B) $\text{H}_2\text{SO}_4/\text{HNO}_3$ followed by $\text{NH}_3/\text{NH}_2^-$
- (C) NaNO_2/HCl followed by $\text{NH}_3/\text{NH}_2^-$
- (D) $(\text{CH}_3\text{CO})_2\text{O}$ followed by $\text{NH}_3/\text{NH}_2^-$
- (E) None of the above

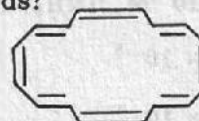
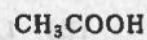
44. Which is the most acidic of the following compounds?



(D)

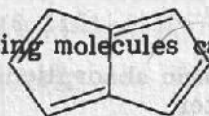


(E)



45. Which of the following molecules can be considered aromatic?

(A)



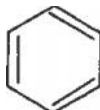
(D)

(B)

(E)



(C)



pH 7

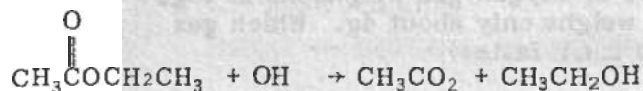
Molarity

46. The above titration curve shows HCl being titrated with which of the following?
- (A) CH_3COOH (D) NH_3
(B) NaOH (E) CH_3NH_2
(C) H_2SO_4 (dilute)
47. $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
For the above equation, calculate the ionization constant if the $[\text{NH}_4^+]$ is 10^{-4}M , $[\text{NH}_3]$ is 1.0M and $[\text{OH}^-]$ is 0.18M respectively.
- (A) 1.8×10^{-5} (D) 1.8
(B) 1.8×10^{-4} (E) 1.8×10^{-3}
(C) 10^{-5}
48. Which of the following instruments may be used to measure the optical activity of compounds?
- (A) Infrared spectrometer (D) Atomic absorption spectrometer
(B) Polarimeter (E) Fluoroscope
(C) Nuclear magnetic resonance spectrometer
49. A solution contains 0.01 mol KI , 0.10 mol KBr and 0.10 mol KCl per liter. AgNO_3 is gradually added to this solution. Which will be precipitated first, AgI , AgBr or AgCl ?
(Solubility products are $K_{\text{AgI}} = 1.5 \times 10^{-16}$, $K_{\text{AgBr}} = 3.3 \times 10^{-13}$, $K_{\text{AgCl}} = 1.8 \times 10^{-10}$)

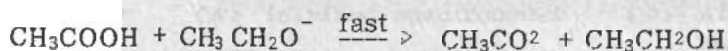
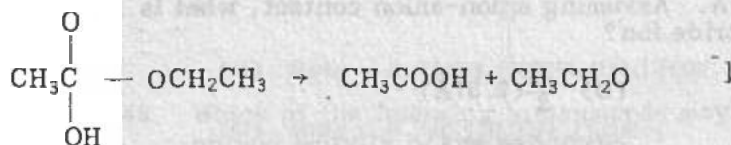
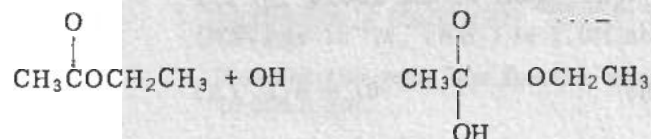
- (A) AgI (D) Both AgBr and AgCl
 (B) AgBr (E) Cannot solve with given information.
 (C) AgCl
50. The excitation of outer electrons in atoms and molecules is associated with which of the following bands of radiation?
- (A) X-rays (D) Infrared
 (B) Gamma rays (E) Microwave and radio
 (C) Ultra violet
51. At standard conditions 45 liters of oxygen gas weighs about 64g, whereas 45 liters of hydrogen weighs only about 4g. Which gas diffuses faster? Calculate how much faster.
- (A) hydrogen, $4r_{O_2}$ (D) oxygen, $3r_{H_2}$
 (B) hydrogen, $2r_{O_2}$ (E) None of the above
 (C) oxygen, $8r_{H_2}$
52. The unit cell cube edge length for LiCl (NaCl- like structure, face centered cubic) is 5.14 \AA . Assuming anion-anion contact, what is the ionic radius for chloride ion?
- (A) $\sqrt{2}(5.14 \text{ \AA})$ (D) $\frac{\sqrt{2}}{2}(2.57 \text{ \AA})$
 (B) $\frac{\sqrt{2}}{2}(5.14 \text{ \AA})$ (E) $\sqrt{2}(2.57 \text{ \AA})$
 (C) $\frac{1}{2}(5.14 \text{ \AA})$
53. Which of the following is not true for metalloids?
- (A) They are borderline elements that exhibit both metallic and non-metallic properties to some extent.
 (B) They usually act as electron donors with non-metals and as electron acceptors with metals.
 (C) Some of these elements are Boron, silicon and Germanium.

- (D) They are all solids at room temperature.
- (E) They are good conductors of heat and electricity.

54.



A mechanism proposed for the above reaction is as follows:



Predict the rate law for the reaction. If the rate constant is given to be 0.1M.

(A) Rate = 0.1[CH₃COO⁻][CH₃CH₂OH]

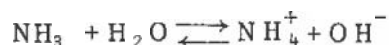
(B) Rate = 0.1[CH₃COCH₂CH₃][OH⁻]

(C) Rate = 0.1[CH₃COO⁻][OH⁻]

(D) Rate = 0.1[CH₃CH₂O⁻][CH₃COOH]

(E) Rate = 0.1[OH⁻][CH₃COOH]

55. A 0.10M solution of aqueous ammonia, also containing ammonium chloride, has a hydroxide ion concentration of $3.6 \times 10^{-6}\text{M}$. What is the concentration of the ammonium ion in the solution if the ionization constant of the following reaction is 1.8×10^{-5} ?

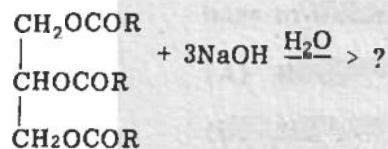


- (A) 0.50 (D) 0.34
 (B) 0.94 (E) 0.74
 (C) 0.64
56. Which of the following has the highest boiling point?
- (A) CH_3OH (D) $\text{CH}_3\text{CH}_2(\text{CH}_3)_2\text{COH}$
 (B) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ (E) $\text{CH}_3(\text{CH}_2)_4\text{OH}$
 (C) $\text{CH}_3\text{CH}_2\overset{\text{OH}}{\underset{|}{\text{CH}}}\text{CH}_3$
57. Acids are classified as monoprotic or polyprotic. Which of the following is a polyprotic acid?
- (A) $\text{CH}_3\text{CO}_2\text{H}(\text{aq})$ (D) $\text{HOCl}(\text{aq})$
 (B) $\text{HCHO}_2(\text{aq})$ (E) $\text{H}_2\text{CO}_3(\text{aq})$
 (C) $\text{HCN}(\text{aq})$
58. In a Born-Haber cycle, the total energy involved in the preceding hypothetical preparation of NaCl is equal to the experimentally determined heat of formation (Q) of the compound from its elements. Which of the following thermochemical values is not used to calculate the total energy of formation of NaCl?
- (1) Heat of fusion and vaporization (S)
 (2) Dissociation energy of molecular chlorine (D)
 (3) Ionization energy of sodium atom (I)
 (4) Electron affinity of chlorine atom (E)
 (5) Lattice energy of NaCl (U)
- (A) (1) and (2) (D) (1), (2), (3) and (5)
 (B) (2), (3) and (5) (E) All of the above
 (C) (1), (2), (3) and (4)

59. The group IA oxides of the M_2O type (Na_2O , K_2O , etc.) are white solids that are extremely sensitive to moisture and carbon dioxide, reacting to form which of the following?
- (A) hydroxides (MOH) and carbonates (M_2CO_3)
 - (B) hydroxides (M_2OH) and carbonates (MCO_3)
 - (C) hydroxides ($M(OH)_2$) and carbonates (MCO_3)
 - (D) hydroxides (MOH) and carbonates (MCO_3)
 - (E) None of the above
60. Which of the following ions can act as both a Bronsted acid and base in water?
- (A) HCO_3^-
 - (B) SO_4^{2-}
 - (C) NO_3^-
 - (D) CN^-
 - (E) PO_4^{3-}
61. Which of the following represents the equation of standing waves?
- (A) $\psi(x) = A\sin(2\pi x/\lambda) - B\cos(2\pi x/\lambda)$
 - (B) $\psi(x) = A\sin(2\pi x/\lambda) + B\cos(2\pi x/\lambda)$
 - (C) $\psi(x) = A\cos(n\pi x/L)$
 - (D) $\psi(x) = B\cos(n\pi x/L)$
 - (E) $\psi(x) = A\sin(2\pi x/L)$
62. Calculate ΔS_{298}° for the reaction below.
- $$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$
- Given that $S_{H_2}^\circ(g) = 31.21 \text{ eu}$, $S_{O_2}^\circ(g) = 49.00 \text{ eu}$, and $S_{H_2O}^\circ(l) = 16.72 \text{ eu}$
- (A) $+122.86 \text{ eu}$
 - (B) -122.86 eu
 - (C) -33.44 eu
 - (D) -77.98 eu
 - (E) -63.49 eu

63. Which of the following oxidizing titrants would most likely be used as its own indicator in acid solution?
- (A) H_2O_2 (D) KMnO_4
(B) $(\text{NH}_4)_2\text{Ce}(\text{NO}_3)_6$ (E) I_2
(C) $\text{K}_2\text{Cr}_2\text{O}_7$
64. If the ionization energy for an electron in the first quantum state of a hydrogen atom is 13.6 eV, what is the ionization energy for an electron in the second quantum state?
- (A) $(13.6/e)\text{eV}$ (D) $3(13.6)\text{eV}$
(B) $(13.6/4)\text{eV}$ (E) $(13.6/2)\text{eV}$
(C) $2(13.6)\text{eV}$
65. Calculate the ionic strength of a 0.01M barium chloride solution.
- (A) 0.03 (D) 0.02
(B) 0.04 (E) 0.005
(C) 0.01
66. A compound $\text{C}_4\text{H}_7\text{Cl}_3$ has the following HNMR spectrum: δ , ppm: 0.9(t, 3H); 1.7(m, 2H); 4.3(m, 1H), 5.8(d, 1H). Which of the following compounds represent the above?
- (A) $\text{CH}_3 - \text{CCl}_2 - \text{CH}_2 - \text{CH}_2\text{Cl}$
(B) $\text{CH}_3 - \text{CH}_2 - \text{CHCl} - \text{CH}_2\text{Cl}_2$
(C) $\text{CH}_3\text{CH}_2 - \text{CCl}_2 - \text{CH}_2\text{Cl}$
(D) $\text{CH}_3 - \text{CHCl} - \text{CH}_2 - \text{CHCl}_2$
(E) $\text{CH}_2\text{Cl} - \text{CH}_2 - \text{CHCl} - \text{CH}_2\text{Cl}$

67. The alkaline hydrolysis of the ester shown below, yields which of the given products?



- (A) $\begin{array}{c} \text{CH}_2 - \text{OH} \\ | \\ \text{CHOH} \\ | \\ \text{CH}_2\text{OH} \end{array} + 3\text{RCO}_2^-\text{Na}^+$ (D) $\begin{array}{c} \text{CH}_2 - \text{OH} \\ | \\ \text{CH}_2 - \text{OH} \\ | \\ \text{CH}_2 - \text{OH} \end{array} + 3\text{RCO}_2^-\text{Na}^+$
- (B) $\begin{array}{c} \text{CH}_2\text{OR} \\ | \\ \text{CHOR} \\ | \\ \text{CH}_2\text{OR} \end{array} + 3\text{HCO}_2^-\text{Na}^+$ (E) $\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CH} - \text{OH} \\ | \\ \text{CH}_2 - \text{OR} \end{array}$
- (C) $\begin{array}{c} \text{CH}_2\text{OR} \\ | \\ \text{CH}_2\text{OR} \\ | \\ \text{CH}_2\text{OR} \end{array} + 3\text{HCO}_2^-\text{Na}^+$

68. Which of the following will not show cis-trans isomerism?

- (A) $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ (D) $\begin{array}{c} \text{Cl} \quad \text{Cl} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$
- (B) $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{Br} \quad \text{CH}_2\text{CH}_3 \end{array}$ (E) $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{CH}_2\text{CH}_3 \end{array}$
- (C) $\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$

69. Which of the following pentapeptides will not be hydrolysed by chymotrypsin?

- (A) Tyr - Cys - Lys - Gly - Pro
- (B) Cys - Lys - Gly - Pro - Tyr
- (C) Lys - Gly - Pro - Tyr - Cys
- (D) Gly - Pro - Tyr - Cys - Lys
- (E) Pro - Tyr - Cys - Lys - Gly

70. Which of the following is the strongest oxyacid?

- (A) HClO_4
- (B) HClO_3
- (C) HClO_2
- (D) HOCl
- (E) ClO^-

71. The activation energy of a reaction can be determined from the slope of which of the following graphs?

- (A) $\ln K$ vs T
- (B) $\frac{\ln K}{T}$ vs T
- (C) $\ln K$ vs $\frac{1}{T}$
- (D) $\frac{T}{\ln K}$ vs $\frac{1}{T}$
- (E) $\frac{\ln K}{T}$ vs $\frac{1}{T}$

72.

[X]	[Y]	rate
1.0	1.0	0.01
1.0	2.0	0.02
3.0	1.0	0.09

The rate data for the net reaction $X + Y \rightarrow Z$ was obtained at 25°C . The initial rate of increase in $[Z]$ is

- (A) second order in both X and Y
- (B) first order in X and second order in Y
- (C) second order in X and zero order in Y
- (D) second order in X and first order in Y
- (E) first order in both X and Y

73. By the linear combination of atomic orbitals, the hamiltonian for the electronic and nuclear repulsion energies of H_2^+ could be represented by which of the following?

(A) $H(r_A, r_B, r_1) = -\frac{1}{2}\bar{V}_1^2 - \left(\frac{1}{r_{A1}}\right) - \left(\frac{1}{r_{B1}}\right) - \frac{1}{R}$

(B) $\hat{H}(r_A, r_B, r_1) = \frac{1}{2}\bar{V}_1^2 - \left(\frac{1}{r_{A1}}\right) + \left(\frac{1}{r_{B1}}\right) - \frac{1}{R}$

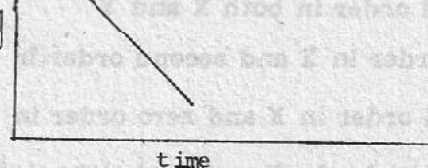
(C) $H(r_A, r_B, r_1) = -\frac{1}{2}\bar{V}_1^2 + \left(\frac{1}{r_{A1}}\right) + \left(\frac{1}{r_{B1}}\right) + \frac{1}{R}$

(D) $H(r_A, r_B, r_1) = \frac{1}{2}\bar{V}_1^2 + \left(\frac{1}{r_{A1}}\right) + \left(\frac{1}{r_{B1}}\right) + \frac{1}{R}$

(E) $\hat{H}(r_A, r_B, r_1) = \frac{1}{2}\bar{V}_1^2 - \left(\frac{1}{r_{A1}}\right) - \left(\frac{1}{r_{B1}}\right) - \frac{1}{R}$

74. A solution contains the following ions: Ag^+ , Hg_2^{2+} , Al^{3+} , Cd^{2+} , Sr^{2+} . The addition of dilute HCl will precipitate

- (A) Ag chloride only (D) Al and Sr chlorides
(B) Al and Cd chlorides (E) Ag and Hg chlorides
(C) Ag, Cd and Sr chlorides



75. Consider the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$. What is the order of this reaction from the following straight line plot?

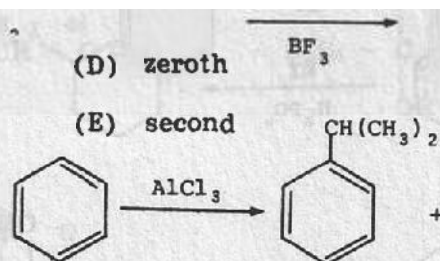
(A) third

(D) zeroth

(B) fourth

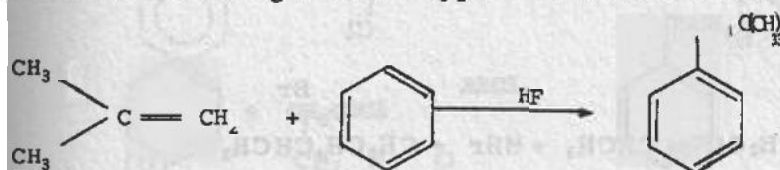
(E) second

(C) first



76. Which of the following is NOT a typical reaction of benzene?

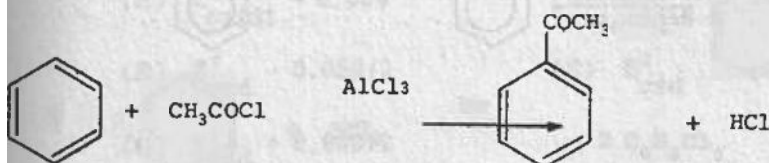
(A)



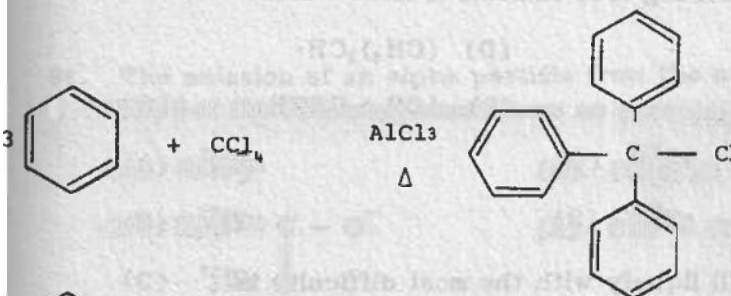
(B)



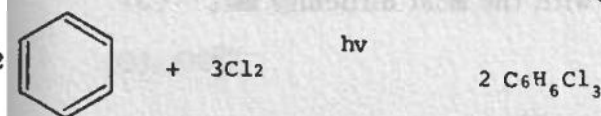
(C)



(D)



(E)



77. Which of the following ions shows no resonance stabilization?

(A) RCO_2^-

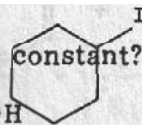
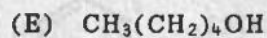
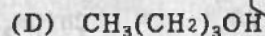
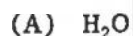
(D) $(\text{CH}_3)_3\text{C}^+$

(B) $\text{R}_2\text{C}=\text{C}(\text{R})-\text{O}^-$

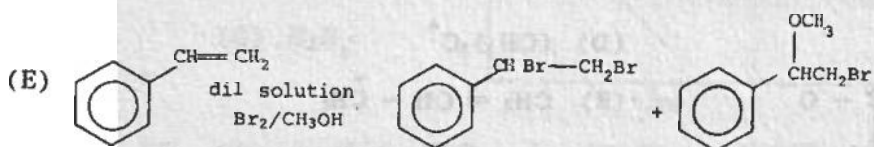
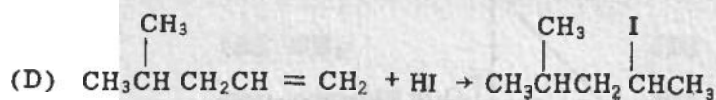
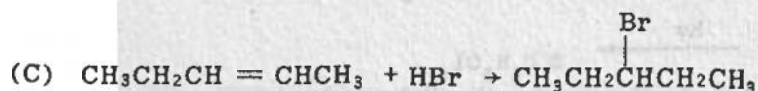
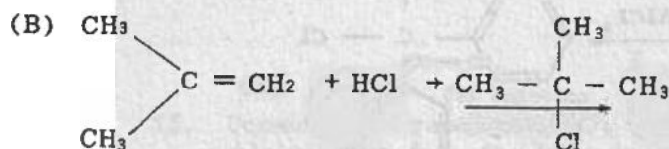
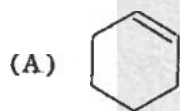
(E) $\text{CH}_2=\text{CH}-\text{C}^+\text{H}_2$

(C) CO_3^{2-}

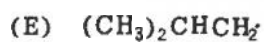
78. Which of the following has the highest dielectric constant?



79. Which of the following reactions of alkenes is incomplete?



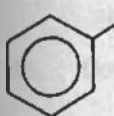
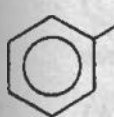
80. Which of the following free radicals is most stable?



81. The gas that will liquefy with the most difficulty is

- (A) He (D) SO₂
 (B) CO₂ (E) H₂O
 (C) NH₃

82. Treating benzaldehyde with acetone in 20% NaOH at 100°C gives which compound as the main product?

- (A)  $\text{C}_6\text{H}_5\text{CH}=\text{CH}-\text{CHO}$ (D) $\text{C}_6\text{H}_5-\text{C}(\text{OH})(\text{H})-\text{CH}_2-\text{C}(=\text{O})-\text{OH}$
 (B)  $\text{C}_6\text{H}_5\text{CH}=\text{C}(\text{H})-\text{CO}-\text{CH}_3$ (E) $\text{C}_6\text{H}_5-\text{C}(\text{H})=\text{C}(\text{H})-\text{C}(=\text{O})-\text{C}_6\text{H}_5$
 (C) $\text{CH}_3-\text{C}(\text{CH}_3)=\text{C}(\text{H})-\text{C}(=\text{O})-\text{CH}_3$

83. What is the potential of a half cell consisting of a platinum wire dipped into a solution 0.01M in Sn²⁺ and 0.001M in Sn⁴⁺ at 25°C?

- (A) $E^\circ_{\text{oxid.}} + 0.059$ (D) $E^\circ_{\text{oxid.}} - 0.059$
 (B) $E^\circ_{\text{red}} - 0.059/2$ (E) E°_{red}
 (C) $E^\circ_{\text{red}} + 0.059/2$

84. The emission of an alpha particle from the nucleus of $^{226}_{88}\text{Ra}$ will yield

- (D) $^{222}_{87}\text{Fr}$
 (B) $^{222}_{86}\text{Rn}$ (E) $^{222}_{88}\text{Ra}$
 (C) $^{223}_{87}\text{Fr}$

85. If Mn^{2+} ion is coordinated to ligands of higher field strength, what happens to the complex?

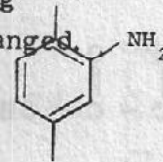
(A) Electrons are forced into higher energy (e_g) level.

(B) The stability of the complex remains unchanged.

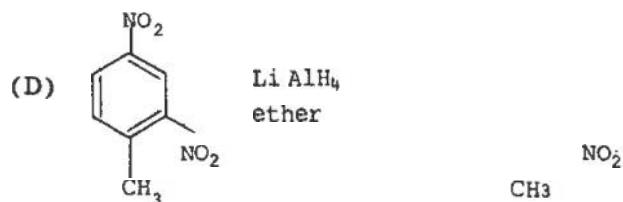
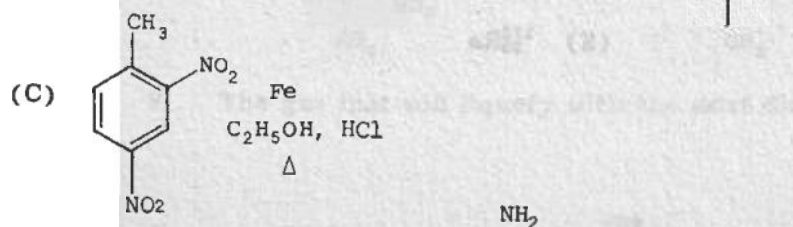
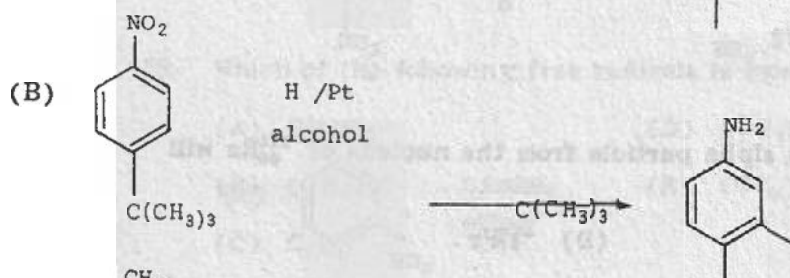
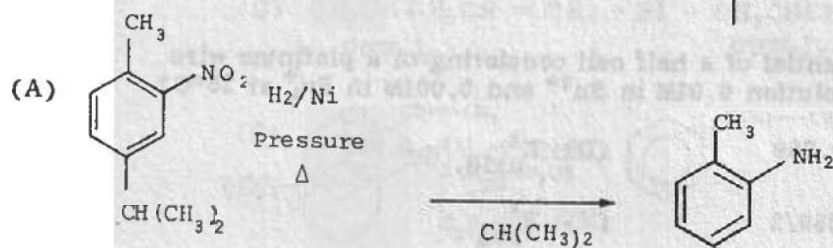
(C) The complex would be colorless.

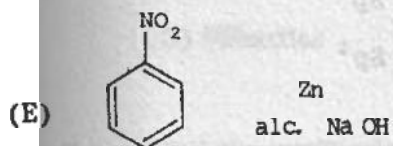
(D) The complex will become less stable.

(E) The complex will become more stable.



86. Which of the following reactions is ~~unlikely to be~~ correct?





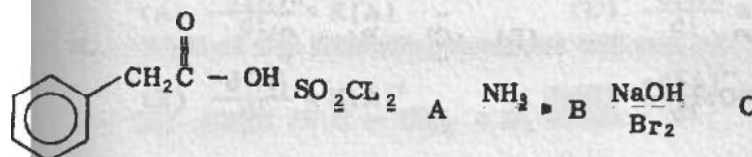
87. Which of the following functional groups is not ortho, para directing and activating?

- (A) R (D) OH
(B) NH₂ (E) COR
(C) NR₂

88. Gabriel's synthesis is used frequently in the preparation of which of the following?

- (A) Primary amines (D) β-amino carboxylic acids
(B) Tertiary amines (E) Azide compounds
(C) Primary alcohols

89. Consider the following series of reactions:



compound C is:

- (A) acidic (D) neutral
(B) basic (E)
(C) bromoketone

90. Which of the following reactions will not take place?

- (A) $\text{CH}_3\text{C} \equiv \text{C} - \text{CH}_3 + \text{H}_2 \xrightarrow{\text{Pd}}$
(B) $\text{CH}_3\text{C} \equiv \text{CH} + \text{H}_2\text{O} \xrightarrow[\text{HgSO}_4]{\text{H}_2\text{SO}_4}$

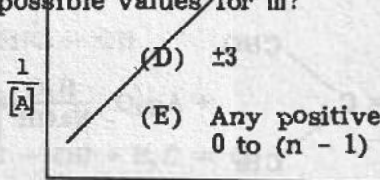
- (A) Plastic
- (B) Petroleum
- (C) Glycogen
- (D) Starch
- (E) Natural rubber

96. One would expect to find the term isotactic used in connection with which one of the following?

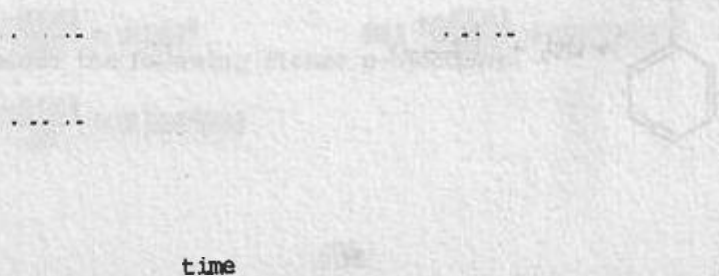
- (A) Crystals
- (B) Dyes
- (C) Textiles
- (D) Metals
- (E) Plastics

97. There are three quantum numbers, n , l , and m (all integers), characterizing each solution of the Schrodinger equation. If $n = 3$, what is the range of possible values for m ?

- (A) 0
- (B) ± 1
- (C) ± 2
- (D) ± 3
- (E) Any positive number from 0 to $(n - 1)$



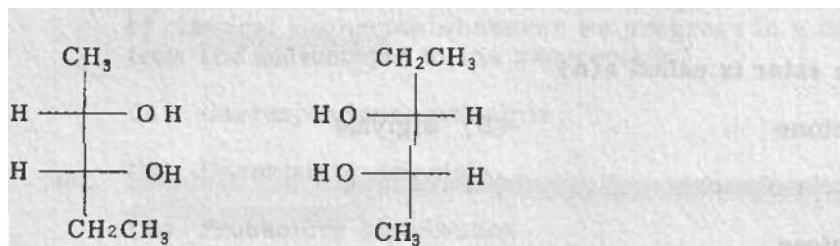
98. For the reaction $A + B \rightarrow C$ the change in $[A]$ with time is shown in the graph below. What is the rate law for this reaction?



- (A) $-\frac{d[A]}{dt} = K[A]$
- (B) $-\frac{d[A]}{dt} = K[A]^2$
- (C) $-\frac{d[A]}{dt} = K[A]^2[B]$
- (D) $-\frac{d[A]}{dt} = K[A][B]$
- (E) $-\frac{d[A]}{dt} = K[A][B]^2$

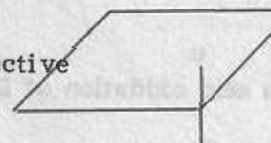
99. A device in which incident radiation is converted to electric current is called
- (A) a phototube (D) an ammeter
- (B) a voltaic cell (E) None of the above
- (C) an amplifier
100. In the quantum theory, which of the following tells us that the predictions of quantum mechanics must pass smoothly into those of classical mechanics whenever we progress in a continuous way from the microscopic to the macroscopic?
- (A) Correspondence principle
- (B) Uncertainty principle
- (C) Probability distribution
- (D) Probability density theory
- (E) Electronic configuration theory
101. Which of the following reactions will not yield (completely) a carboxylic acid?
- (A) $\text{CH}_3(\text{CH}_2)_9\text{CN} + 2\text{H}_2\text{O} \xrightarrow[\text{C}_2\text{H}_5\text{OH}]{\text{KOH}} \xrightarrow{\text{HCl}}$
- (B) $\text{CH}_3\text{CH}_2\text{CHClCH}_3 + \text{Mg} \xrightarrow[\text{CO}_2]{\text{ether}}$
- (C) $\begin{array}{c} \text{H} \qquad \qquad \text{CHO} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3\text{CH}_2 \quad \text{CH}_3 \end{array} + \text{Ag}_2\text{O} \xrightarrow[\text{NaOH}]{\text{H}_2\text{O}}$
- (D) $\text{CH}_3(\text{CH}_2)_3\underset{\text{CH}_2\text{CH}_3}{\text{CH}}\text{CHO} + \text{KMnO}_4 \xrightarrow[\text{NaOH}]{\text{H}_2\text{O}} \xrightarrow{\text{H}_2\text{SO}_4}$
- (E) $\text{C}_6\text{H}_5\text{Li} + \text{CO}_2 \xrightarrow{\text{H}^+}$

102. The system $\text{CaCO}_3:\text{CaO}:\text{CO}_2$ has
- (A) 3 components, 1 phase and 2 degrees of freedom
 - (B) 2 components, 2 phases and 1 degree of freedom
 - (C) 3 components, 3 phases and zero degree of freedom
 - (D) 3 components, 2 phases and 3 degrees of freedom
 - (E) 2 components, 3 phases and 1 degree of freedom
103. A cyclic ester is called a(n)
- (A) lactone
 - (B) semicarbazone
 - (C) lactose
 - (D) diglyme
 - (E) dioxane
104. Periodic acid oxidation of D-glucose in aqueous solution gives
- (A)
$$4\text{H} - \overset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{OH} + 2\text{H}_2\text{C} = \text{O}$$
 - (B)
$$4\text{H}_2\text{C} = \text{O} + 2\text{HC} - \overset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{OH}$$
 - (C)
$$\text{CO}_2 + 5\text{HC} - \overset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{OH}$$
 - (D)
$$5\text{H} - \overset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{OH} + \text{H}_2\text{C} = \text{O}$$
 - (E)
$$5\text{H}_2\text{C} = \text{O} + \text{H} - \overset{\text{O}}{\underset{\parallel}{\text{C}}} - \text{OH}$$
105. Consider the following Fisher projections:

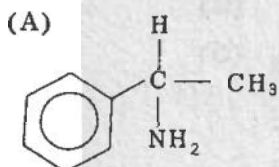


These compounds are

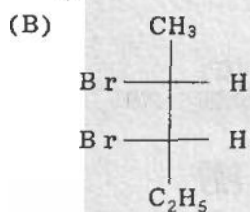
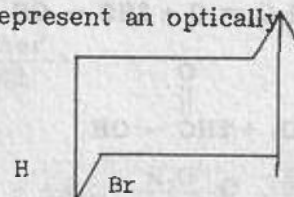
- | | |
|-------------------|---------------------|
| (A) identical | (D) stereoselective |
| (B) enantiomers | (E) meso |
| (C) diastereomers | |



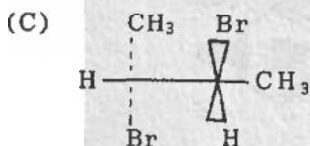
106. Which of the following structures does not represent an optically active compound?



(D)



Br

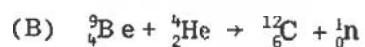
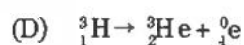
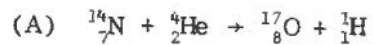


(E)

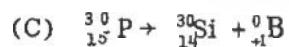
Br

CH

107. Which of the following nuclear reactions is INCORRECT?



(E) None of the above



108. Brass is an alloy of
- (A) copper and tin
 - (B) copper and zinc
 - (C) aluminium and nickel
 - (D) aluminium and copper
 - (E) lead and tin
109. Which of the following terms is not associated with nuclear magnetic resonance spectroscopy?
- (A) Tetramethylsilane
 - (B) Chemical shift
 - (C) Coupling constant
 - (D) Nuclear spin
 - (E) Molar extinction coefficient
110. The structure of ClO_3F is closest to:
- (A) tetrahedral
 - (B) trigonal-planar
 - (C) square-planar
 - (D) trigonal-bipyramidal
 - (E) linear
111. In a trigonal-bipyramidal crystal field the d orbitals of a metal will be split into
- (A) six levels
 - (B) five levels
 - (C) four levels
 - (D) three levels
 - (E) two levels
112. The least polarized anion is
- (A) SO_4^{2-}
 - (B) IO_4^-
 - (C) ClO_4^-
 - (D) $\text{C}_2\text{O}_4^{2-}$
 - (E) NO_3^-
113. A compound that has been used as a rocket fuel is

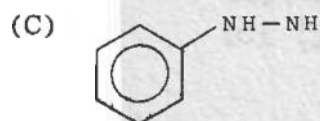
- (A) NH_2OH (D) NO_2
 (B) NH_2NH_2 (E) NF_3
 (C) N_2F_2

114. The weakness in the Bohr model of an atom is

- (A) the electron was treated as a wave rather than a particle
 (B) the model only worked for hydrogen atom
 (C) the neutron was not considered
 (D) it neglected the radiation emitted by accelerating charged bodies
 (E) None of the above

115. Which reagent will react with benzaldehyde to yield a phenylhydrazone?

- (A) NH_2NH_2 (D) NH_2OH



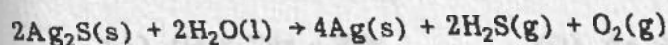
116. The most basic species among the following is

- (A) H_2O (D) OH^-
 (B) CH_3^- (E) F^-
 (C) NH_2^-

117. The height to which a liquid will rise in an open capillary tube is inversely proportional to:

(A) temperature of liquid (D) surface tension
(B) density of liquid (E) viscosity of the liquid
(C) air pressure

118. Calculate ΔH° for the reaction



if $\Delta H^\circ_{\text{H}_2\text{S(g)}} = -20.6 \text{ kJ/mol}$, $\Delta H^\circ_{\text{Ag}_2\text{S(s)}} = -32.6 \text{ kJ/mol}$,

$\Delta H^\circ_{\text{H}_2\text{O(l)}} = -285.8 \text{ kJ/mol}$

(A) 595.6 kJ (D) 485.6 kJ
(B) 495.6 kJ (E) 600 kJ
(C) 585.6 kJ

119. How long will it take for a sample of radioactive material to disintegrate to the extent that only 2% of the original concentration remains if the material has a half-life of 5.2 years? Note that

$$\ln(C_0/C) = kt.$$

(A) $\frac{\ln 2}{\ln(5.2)}$ (D) $\frac{(\log 50)(5.2)}{(\log 2)(2.303)}$
(B) $\left(\frac{\ln 50}{\ln 2}\right) 5.2$ (E) $\left(\frac{\ln(0.02)}{\ln 2}\right) 5.2$
(C) $(\ln 0.02)(5.2)$

120. Calculate the volume of 4M HCl needed to prepare 1 liter of a 0.5M solution.

(A) 0.125 l (D) 0.0875 l
(B) 0.0125 l (E) 12.5 l
(C) 0.875 l

121. Which of the following cations has the highest mobility?

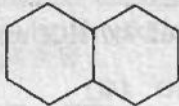
- (A) Be^{2+} (D) H^+
(B) Mg^{2+} (E) Ca^{2+}
(C) Rb^+

122. The first scientist to publish on the periodic table was

- (A) Moseley (D) Dalton
(B) Fisher (E) Gay Lussac
(C) Mendeleev

123. Which of the following compounds has the highest melting point?

- (A) NaCl (D) CsCl
(B) KCl (E) CsBr
(C) RbCl

124. What is the IUPAC name of the compound  ?

- (A) (5,5,1)-bicyclodecane (D) (5,5,0)-bicyclodecane
(B) (4,4,1)-bicyclodecane (E) (5,4,1)-bicyclodecane
(C) (4,4,0)-bicyclodecane

125. What is the heat flow under isobaric conditions for a chemical reaction performed in a "solution" calorimeter?

- (A) $\Delta H = \Delta E + \Delta(PV) = \Delta E + W$
(B) $\Delta E = \Delta H - \Delta(PV) = \Delta H - RT\Delta n$

(C) $q = W = \int_{P_1}^{P_2} v dP = nRT \ln \frac{P_1}{P_2} = nRT \ln \frac{V_2}{V_1}$

$$(D) \quad q = W = \int_{v_1}^{v_2} P dv = P \Delta v = P(v_2 - v_1)$$

$$(E) \quad \Delta H = \Delta E = q_v$$

126. Work can be defined as the product of an intensity factor (force, pressure, etc.) and a capacity factor (distance, electrical charge, etc.). Which of the following expressions for thermodynamic work (below), is INCORRECTLY defined?

- (A) Mechanical work $\delta w = f di$
- (B) Surface work $\delta w = \gamma dA$
- (C) Electrical work $\delta w = \epsilon dl$
- (D) Gravitational work $\delta w = mg di$
- (E) None of the above

127. Which of the following Maxwell relations is incorrect?

- (A) $dE = Tds - Pdv$
- (B) $dH = Tds + vdP$
- (C) $dG = -SdT + vdP$
- (D) $dA = -SdT - Pdv$
- (E) None of the above

128. Ethanol boils at 78.5°C . If 34.2g of sucrose (M.W = 342) is dissolved in 200g of ethanol, at what temperature will the solution boil? (Assume $K_b = 1.20^\circ\text{C}/m$ for the alcohol.)

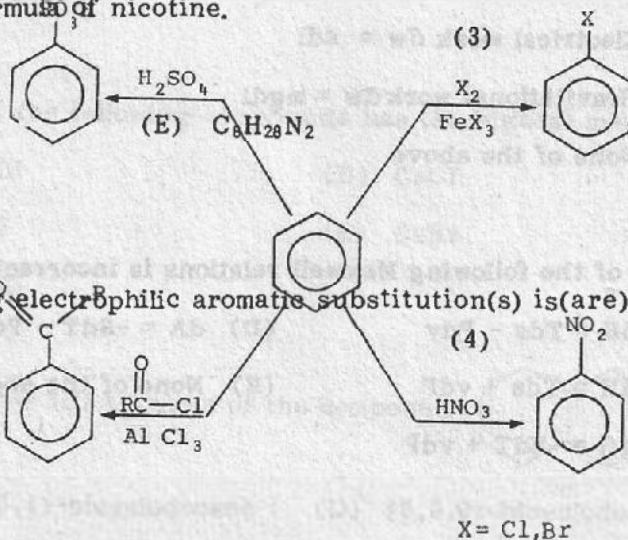
- (A) 79.1°C
- (B) 77.9°C
- (C) 0.60°C
- (D) 78.56°C
- (E) 84.5°C

129. 2.3g of ethanol ($\text{C}_2\text{H}_5\text{OH}$, M.wt = 46g/mole) is added to 500g of water. Determine the molality of the resulting solution.

- (A) 0.01 molal
- (B) 0.1 molal
- (C) 1.0 molal
- (D) 10.0 molal
- (E) 1.1 molal

130. The molecular weight of nicotine, a colorless oil, is 162.1 and it contains 74.0% carbon, 8.7% hydrogen and 17.3% nitrogen. Calculate the molecular formula of nicotine.

- (A) C_5H_7N
(B) $C_{10}H_{14}N_2$



131. Which of the following electrophilic aromatic substitution(s) is(are) correct?

(1)

(2)

- (A) $10^{-4}M$
- (A) (1) and (3) only (D) (1), (2) and (4) only
(B) (2) and (4) only (E) All of the above. (1), (2), (3) and (4)
(C) (1), (2) and (3) only

132. A chemist dissolves an excess of $BaSO_4$ in pure water at $25^\circ C$. If its $K_{Sp} = 1 \times 10^{-10}$, what is the concentration of the barium in the water?

- (D) $10^{-10}M$
(B) $10^{-5}M$ (E) $10^{-20}M$
(C) $10^{-6}M$